EFFECTS OF VARIETAL TYPE AND CROP SEASON ON THE PERFORMANCE OF SOME GRANULAR HERBICIDES IN TRANSPLANTED RICE[1]

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INTRODUCTION

Interest in controlling weeds with herbicides instead of conventional hand weeding in transplanted rice has greatly increased in recent years in Taiwan. The acreage of rice field controlled by herbicides has increased from less than 500 ha in 1966 to nearly 3,600 ha in 1968 (Chang, 1969). In order to encourage rice farmers to adopt the chemical weed control practice, it is necessary that herbicides with good weed control effect with less phytotoxicity to rice should be made available to farmers. For this purpose, a number of weed control experiments have been conducted at the Chiayi Agricultural Experiment Station in cooperation with The International Rice Research Institute during the past several years (Chang, 1965; 1968; 1969).

In Taiwan, two different groups of rice, the indica and japonica types, are commercially grown in two different crop seasons, the first and second crops. Since rice varieties of both indica and japonica types differ greatly in their morphological as well as physiological characters, they may respond quite differently to the application of herbicides. Similarly, the performance of herbicides in the first crop that is generally cold and dry, is likely to vary with that in the hot and wet second crop season. The understanding of the role played by varietal type and crop season on the performance of herbicides may be useful if herbicides are to be evaluated correctly for their performance. For this purpose, two field experiments were set up in both the first and second crops of1970 at the Chiayi Agricultural Experiment Station also in cooperation with The International Rice Research Institute to furnish the necessary information. The results obtained from these experiments are summarized in this paper.

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MATERIALS AND METHODS

Two field experiments were conducted in both the first and second crops of 1970 at the Wan-tien-li farm of the Chiayi Agricultural Experiment Station. Rice varieties, Taichung native 1 and Chianung 242 were used to represent two contrasting varietal types. The former is a short culm, heavy tillering indica variety and the latter, a tall culm, light tillering japonica variety. These two rice varieties were subjected to 11 weed control treatments as listed in Table 1. The field experiment was laid out in a randomized block, split-plot design with four replications. weed control treatments made the whole plots whereas varietal types comprised the subplots. The subplot was 1.0 x 4.0 m in size and consisted of 4 rows. The plant spacing was 25 by 20 cm with approximately 5 seedlings being transplanted at each hill. Ammonium sulphate, calcium superphosphate, and potassium sulphate were used as carriers of N, P_2O_5, and K_2O which were applied at the rate of 120, 60, and 60 kg per ha in the first crop and 80, 40, and 40 kg per ha in the second crop, respectively. Half of nitrogen and total amount of both phosphate and potassium were applied as basic dressing and the other half of nitrogen was applied as top-dressing at 30 and 20 days after transplanting in the first and second crops respectively.

Table 1. Treatment of herbicides.

Treatment number	Herbicide treatment	Formulation concentration (%)	Rate of application (kg/ha active ingredient)	Quantity of formulation (kg/ha)	Time of application
1	2,4-D IPE (G)	3.2	0 8	25.0	4 DAT
2	2,4-D EE (G)	1.5	0.8	53.3	4 DAT
3	CP 53619 (G)	5.0	1.0	20.0	4 DAT
4	CP 53619/2,4-D BE (G)	3.33/1.67	1.0/0.5	30.0	4 DAT
5	Saturn (G)	10	3.0	30.0	4 DAT
6	Saturn (G)	10	3.0	30.0	2/3 Isg
7	EPTC/2,4-D IPE (G)	2.5/1.66	0.75/0.5	30.0	4 DAT
8	MCPCA (G)	2.5	1.25	50.0	4 DAT
9	TCE-styrene/2,4-D IPE (G)	3.0/2.0	0.75/0.5	25.0	4 DAT
10	Untreated control	—	—	—	—
11	Hand weeding	—	—	—	—

DAT=Days after transplanting. lsg=Leaf stage of the grassy weeds.
IPE=Isopropyl ester. EE=Ethyl ester. BE=Butyl ester. G=Granule.

Mixed seeds of *Echinochloa crusgalli*, *Monochoria vaginalis* and, *Cyperus difformis* were broadcast on the plots immediately after transplanting at the rate of 2.0 kg per ha in order to insure a uniform and dense stand of weeds. Herbicides were broadcast to a shallow

(2–3 cm) flood of water at 4 days after transplanting in both crops except treatment 6 which was applied when grassy weeds reached 2 to 3 leaf stage. Levees were made arround the main plots to prevent the interflow of water between neighbor plots.

Weed control and toxicity ratings were made at 15 and 30 days after the application of herbicides as well as at the panicle initiation stage of rice based on 1 to 5 scale. Scale 1 indicates excellent weed control or not toxicity and scale 5, no control of weeds or complete kill of rice plant. Plant height and number of tillers per hill at late tillering stage were taken to express the effect of granular herbicides on the growth of rice plants. Grain yield and components of yield were also measured. Temperature during the early stage of rice growth in both crops of 1970 is given in Table 2. The first crop was transplanted in February 21, 1970 and the second crop, in July 27, 1970.

Table 2. Temperature during the early stage of rice growth.

	First crop, 1970			Second crop, 1970		
	Maximum (°C)	Minimum (°C)	Average (°C)	Maximum (°C)	Minimum (°C)	Average (°C)
Up to DOA	27.5	16.6	22.1	32.9	25.7	29.4
1 to 5 DAA	27.0	15.9	21.5	32.9	25.8	29.4
6 to 10 DAA	25.6	13.9	19.8	32.9	25.5	29.2
11 to 15 DAA	22.9	15.3	19.1	32.5	26.1	29.3
16 to 20 DAA	25.8	13.8	19.8	32.4	25.1	28.8
21 to 25 DAA	19.4	13.6	16.5	31.7	25.3	28.5
26 to 30 DAA	21.4	15.2	18.3	32.1	24.6	28.4
31 to 35 DAA	25.4	16.6	21.0	32.7	25.7	29.2
36 to 40 DAA	25.0	14.3	19.7	28.6	24.4	26.5
41 to 45 DAA	28.7	18.6	23.7	—	—	—
46 to 50 DAA	26.7	17.2	22.0	—	—	—
51 to 55 DAA	29.8	20.7	25.3	—	—	—
55 to 60 DAA	28.4	18.6	23.5	—	—	—

DOA=The day of application of herbicides.

DAA=Days after application of herbicides.

RESULTS AND DISCUSSION

Effect of varietal Type and Crop Season on the Infestation of weed.

The infestation of weeds in the experimental plots was predominantly broadleaf and sedge weeds while grassy weeds occupied only a small fraction of the total weed population (Table 3). The most common broadleaf weeds were *Monochoria vaginalis, Lindernia cordifolia, Marsilea quadrifolia, Rotala indica,* and *Spirodela polyrhiza*. *Cyperus difformis* and *Fimbristylis miliacea* were the most important sedges whereas *Echinochloa crusgalli, Paspalum scrobiculatum,* and *Leptochloa chinensis* were the major grassy weeds in the untreated plots.

Table 3 also shows that the number of weeds in the plots of indica type variety, Taichung native 1 was considerably smaller than that of japonica type variety, Chianung 242 indicating that Taichung native 1 was capable of producing more tillers and leaving less space for weeds to grow. The successful competition of the heavy-tillering variety with weeds was also reported(IRRI, 1969). The growth of weeds in the second crop was generally better than that of the first one, showing that high temperature plays an important role on the growth of weeds. It was observed that the growth of *Monochoria vaginalis* varied most greatly with crop seasons among major weeds of transplanted rice, indicating that it requires high temperature to attain vigorous vegetative growth, although its number may not vary greatly with crop seasons. This difference in weed growth at different crop seasons may be largely reponsible for the difference in weed damage to rice at different crop seasons as reported by Chang (1970).

Table 3. The infestation of weeds in the untreated control one month after transplanting (weeds/m^2)

	First crop, 1970			Second crop, 1970		
	Taichung native 1	Chianung 242	Total	Taichung native 1	Chianung 242	Total
Grasses	20	30	50	25	30	55
Broadleaves	340	450	790	480	505	985
Sedges	160	170	330	85	150	235
Total	520	650	1,170	590	685	1,275

Effect of Varietal Type and Crop Season on Weed Control of Herbicide Treatments.

Wheed control ratings made at different stages of rice growth are presented in Table 4. As a whole, the weed control effect of granular herbicides tested in this experiment was generally acceptable. Both 2, 4-D isopodyl ester (IPE) and 2,4-D ethyl ester (EE) appeared to be equally effective in the control of weeds especially those of broadleaf and sedge. How-

ever, the number of surviving *Echinochloa crusgalli* in the plots of these treatments was much more than that of other treatments, suggesting that grass controlling effect of these two 2,4-D esters may need further improvement, although some control of *Echinochloa crusgalli* by 2,4-D IPE has been observed(Chang, 1969; Chang *et al.*, 1970). Single application of CP 53619 did provide good control of weeds but CP 53619/2,4-D butyl ester (BE) apparently controlled weeds better than that of CP 53619 applied alone, indicating that the inclusion of 2,4-D BE greatly enhences the weed control effect of CP 53619. Saturn granule applied at 4 days after transplanting gave good control to a very wide spectrum of weeds whereas the same herbicide applied at 2-3 leaf stage of grassy weeds or at 14 and 9 days after transplanting in the first and second crops respectively, gave the poorest control of weeds, showing that Saturn controls weeds most effectively when it is applied before the emergence of weeds but it fails to control most broadleaf and sedge weeds that emerge before treatment. *Spirodela polyrhiza*, a floating weed, was controlled only by CP 53619, CP 53619/2,4-D BE and pre-emergence treatment of Saturn. The weed control effect of EPTC /2,4-D IPE was slightly better than that of postemergence treatment of Saturn, but inferior to most of the other herbicides tested in this experiment. The performance of MCPCA and TCE-styrene/2,4-D IPE was very similar and both herbicides appeared to provide satisfactory control of weeds.

weed control effect of herbicides varied very slightly with varietal types when rice plants were still small. However, when rice plants were fully developed, difference in weed control effect became evident. From Table 4, it can be seen that a given herbicide gave considerably smaller value of weed control rating to indica rice, Taichung native 1 than that to japonica rice, Chianung 242, when the rating was made at panicle initiation stage. This phenomenon seemed to be more pronounced in herbicides with either poor control of weeds or with relatively short residual weed control effect. The main reason for the weed control ratings of the same herbicide to vary with varietal types at late growing stage of rice may be associated with the tillering ability of rice varieties. Indica rice variety, Taichung native 1 generally produces more tillers than japonica rice variety, Chianung 242. As a result, open space available for weed growth as well as chances for weeds to emerge at late growing stage of rice may become smaller in Taichung native 1 because thick canopy of leaf may have already been constructed by rice tillers at this stage. De Datta *et al.* (1969) also suggested that some suppression of weed growth can be expected about one month after transplanting from the successful competition of a heavy tillering variety with weeds.

The weed control effect of post-emergence treatment of Saturn and EPTC/2,4-D IPE in the first crop at 15 and 30 days after application and for the former herbicide even at pancile initiation stage was slightly better than that of the second crop, but the other herbicides appeared to perform similarly in both crops up to one month after the application. The exact reason for these herbicides to show better weed control in the first crop is not presently clear. It was also observed that weed control effect of 2,4-D IPE, 2,4-D EE and TCE-styrene/2,4-D IPE in the first crop was inferior to that of the second crop. This may be attributable to the high toxicity of these herbicides to rice plants in the first crop which resulted in a complete kill of rice plants or suppression of their growth, thus providing

more space for the growth of weeds.

Table 4. Weed control ratings of granular herbicides in transplanted rice.

Treatment	15 DAA		30 DAA		Panicle initiation stage			
	First crop, 1970	Second crop, 1970	First crop, 1970	Second crop, 1970	First crop 1970		Second crop, 1970	
					TN 1	Ch 242	TN 1	Ch 242
1	1.3	1.3	1.1	1.3	1.6	2.2	1.0	1.4
2	1.1	1.2	1.2	1.2	1.7	2.6	1.0	1.6
3	1.2	1.5	1.7	1.6	1.6	1.7	1.3	2.0
4	1.2	1.1	1.3	1.1	1.4	1.7	1.0	1.3
5	1.3	1.2	1.3	1.2	1.1	1.1	1.0	1.4
6	1.8	2.0	1.6	2.3	1.3	1.3	1.9	2.6
7	1.4	2.3	1.5	2.0	2.2	2.4	1.5	2.4
8	1.3	1.4	1.5	1.3	1.3	1.5	1.1	2.0
9	1.2	1.4	1.3	1.2	1.9	2.2	1.0	1.3
10	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
11	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

DAA=Days after application. TN 1=Tichung native 1
Ch 242=Chianung 242.

Effect of Varietal Type and Crop Season on Rice Toxicity of Herbicide Treatments.

Rice toxicity ratings made at 15 and 30 days after application of heribicides as well as panicle initation stage are shown in Table 5. Among herbicides tested in this experiment, 2, 4-D IPE, 2,4-D EE, and TCE-styrene/2,4-D IPE were found to be most toxic to rice plant, followed by MCPCA, EPTC/2, 4-D IPE, and CP 53619/2,4-D BE with moderate phytotoxicity while CP 53619, Saturn applied at 4 days after transplanting and at 2-3 leaf stage of grassy weeds showed very slight or no phytotoxicity. Most of these toxic herbicides were 2,4-D esters or chemicals incorporated with 2,4-D esters or other phenexy compounds, indicating that these phenexy compounds are largely responsible for inducing phytotoxicity to rice. Although the toxicity of CP 53619 was not evident in this experiment when applied at the rate of 1 kg per ha of active ingredient, this chemical may become highly toxic to rice when applied at the rate of 3 kg per ha of active ingredient (Chang *et al.*, 1970). The problem of low rice tolerance was also reported to show in yield of plots treated with CP 53619 (Baker, 1970).

Table 5. Rice toxicity ratings of granular herbicides in transplanted rice.

Treatment	15 DAA				30 DAA				Panicle initiation stage			
	First crop, 1970		Second crop, 1970		First crop, 1970		Second crop, 1970		First crop, 1970		Second crop, 1970	
	TN 1	Ch 242	TN 1	Ch 242	TN 1	Ch 242	TN 1	Ch 242	TN 1	Ch 242	TN 1	Ch 242
1	2.7	2.3	1.5	1.6	2.8	2.5	1.1	1.4	1.5	2.0	1.0	1.1
2	2.7	2.5	1.7	1.8	3.0	2.6	1.2	1.4	1.6	2.0	1.0	1.3
3	1.1	1.2	1.0	1.1	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0
4	1.4	1.6	1.2	1.4	2.3	1.9	1.0	1.1	1.4	1.9	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.1	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0
7	1.5	1.6	1.0	1.4	2.5	2.0	1.1	1.2	1.3	1.8	1.0	1.0
8	1.7	1.6	1.9	1.9	2.0	2.1	1.3	1.5	1.4	2.4	1.0	1.3
9	2.3	2.3	1.7	1.7	3.0	3.0	1.2	1.4	1.8	2.5	1.0	1.3
10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
11	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

DAA=Days after application. TN 1=Taichung native 1. Ch 242=Chianung 242.

Phytotoxicity of herbicides to rice plants was manifested in several ways. The commonly found symptoms were yellowing of rice leaves, stunting growth of rice plants, decrease in the number of tillers per hill, development of onion leaves, and even complete kill of rice plants. The phytotoxicity of herbicides was also reflected in the growth of rice plant measured at late tillering stage (Table 6). Plant height and number of tillers per hill of rice plants in the plots of toxic herbicides were considerably smaller when compared with those of hand weeding. However, most of rice injuries were able to recover before rice reached pancile initiation stage.

Toxicity ratings of Taichung native 1 at 15 and 30 days after application of herbicides were slightly higher than those of Chianung 242, showing that rice seedlings of the indica variety were more sensitive to the toxicity of herbicides. However, when toxicity was rated at panicle initiation stage, Chianung 242 appeared to show heavier toxicity than Taichung native 1, indicating that the indica variety was capable of recovering more rapidly from

injury caused by herbicides than japonica variety. As Taichung native 1 usually produces more tillers than Chianung 242, tillering ability of rice is likely to be associated with varietal difference in the recovery from phytotoxicity.

Table 6. The growth of rice plants recorded at late tillering stage.

Treatment	Plant height (cm)				Number of tillers per hill			
	First crop, 1970		Second crop, 1970		First crop, 1970		Second crop, 1970	
	TN 1	Ch 242	TN 1	Ch 242	TN 1	Ch 242	TN 1	Ch 242
1	33,4	33.8	71.0	86.6	10.1	7.9	20.3	11.3
2	35.2	34.3	70.9	85.4	11.1	7.5	19.5	11.5
3	41.5	48.7	76.6	90.2	24.4	16.7	18.7	11.0
4	38.8	36.8	71.0	86.3	15.3	7.7	20.3	12.2
5	42.4	49.2	73.2	88.0	27.5	19.0	20.4	11.5
6	41.8	48.5	74.3	89.6	25.6	15.3	18.0	11.3
7	37.9	39.6	74.8	87.2	14.9	9.4	18.2	9.9
8	38.2	37.4	72.7	87.4	16.7	7.8	19.2	10.8
9	37.9	36.8	71 2	87.9	13.8	6.2	17.8	10.1
10	42.3	49.6	74.7	89.2	25.2	16.5	18.0	10.0
11	41.4	48.7	74.1	93.4	25.7	17.7	19.3	11.4
LSD 5%	4.0		NS		3.7		NS	
LSD 1%	5.4				4.9			

TN 1=Taichung native 1. Ch 242=Chianung 242.

It was of interest to note that phytotoxicity of herbicides was more pronounced in the first crop than in the second one. In the first crop, 2,4-D IPE, 2,4-D EE, and TCE-styrene /2,4-D IPE were highly toxic to rice plants and rice injury was still evident even at panicle initiation stage. In the second crop, however, these herbicides showed remarkably mild rice toxicity and rice plants were almost fully recovered from chemical injury at panicle initiation stage. This difference in the injury caused by herbicides at different crop seasons also reflected in the growth of rice plants recoded at late tillering stage (Table 6). In the first crop, differences in both plant height and number of tillers per hill among treatments were significant at 1% level of probability, but they failed to reach a significant

level in the second crop. Since temperature during the early stage of rice growth in the first crop was considerably lower than that of the second one (Table2), it appears likely that low temperature may have contributed greatly to the high toxicity of these phenoxy acid herbicides. This observation was further confirmed by the results of the previous experiment conducted in the first crop of 1969 (Chang, 1969) in which both 2,4-D IPE and TCE-styrene/2,4-D IPE were found to be less toxic to rice plants in comparison with those of this experiment because the minimum temperature in 1969 during the early stage of rice growth was higher than that in 1970.

The infestation of weeds in the paddy field of Taiwan is believed to be mostly broad leaf and sedge weeds and the population density of grassy weeds is considerably lower than that of the former two weeds, although the latter is potentially more destructive to rice (Chang, 1970). Since broadleaf and sedge weeds can be controlled effectively by inexpensive phenoxy acid herbicides, it appears probable that granular formulation. of 2.4-D isopropyl ester can be accepted commercially for transplanted rice in Taiwan. The application of this herbicide should preferably be limited to only in the second crop in view of its relatively low phytotoxicity in this crop season. Furthermore, the potentiality of this chemical can be fully exploited in the second crop when high temperature stimulates the growth of broadleaf and sedge weeds in paddy field.

Effect of Varietal Type and Crop Season on Grain Yields of Herbicide Treatments.

Grain yields of Taichung native 1 and Chianung 242 in the first and second crops of 1970 are shown in Table 7. It was noted that among herbicides tested in this experiment, only Saturn applied at 4 days after transplanting out yielded hand weeding, although several others gave rice yields much higher than that of unweeded treatment. The high yield performance of this treatment appears related to its good weed control and low rice toxicity. It was also observed that Saturn applied at 2-3 leaf stage of the grassy weeds yielded lower than hand weeding due presumably to its poorer control of weeds. This observation clearly demonstrated that pre-emergence application of Saturn was more effective than it applied as post-emergence treatment. This chemical has been officially recommended for use in transplanted rice in Taiwan (Lin, 1970).

The influence of vavietal type on herbicide treatment was revealed in Table 7. Japonica type rice variety, Chianung 242 was found to suffer greater reduction of yield than indica type rice variety Taichung native 1, indicating that profuse tillering indica variety was more tolerant to chemical injury than weak tillering japonica variety. It appears therefore that chemical weed control can be more safely practiced in the paddy fields grown with indica varieties. Grain yield of unweeded treatment was about 16% lower than that of hand weeding for Chianung 242 but only 2 to 8% of yield loss was recorded for Taichung native 1. This difference may indicate that Taichung native 1, the heavy tillering variety, was the more successful competitor with weeds. Yield damage of 16% recorded for Chianung 242 in this experiment was considerably smaller than 30.5% of the previous experiment (Chang 1968)indicating that weed infestation of this experiment was less severe than that of the previous one.

Table 7. Grain yield and number of panicles per hill of Taichung native 1 and Chianung 242 in the first and second crops of 1970.

Treatment	Grain yield (kg/ha)				Number of panicles per hill			
	First crop, 1970		Second crop, 1970		First crop, 1970		Second crop, 1970	
	TN 1	Ch 242	TN 1	Ch 242	TN 1	Ch 242	TN 1	Ch 242
1	5,269 b*	4,941 c-d*	4,823	4,585	13.4 d*	11.0 b-e*	16.5	10.2
2	5,803 a-b	4,510 d	4,893	4,430	13.7 c-d	10.9 b-e	15.3	9.7
3	5,794 a-b	5,878 a-c	4,843	4,558	15.3 a-d	12.7 a-c	15.9	10.0
4	5,775 a-b	5,516 b-d	5,078	4,685	16.4 a-d	12.4 a-d	17.7	10.5
5	6,753 a	6,925 a	5,118	4,938	15.8 a-c	13.0 a-b	17.0	10.9
6	6,610 a-b	5,965 a-c	4,758	4,305	16.5 a-b	10.9 b-e	15.0	9.6
7	5,406 a-b	5,147 c-d	4,933	4,550	14.4 b-d	10.2 d-e	15.3	9.1
8	5,794 a-b	5,228 c-d	4,898	4,218	14.8 a-d	10.5 c-e	15.5	9.0
9	6,025 a-b	4,969 c-d	4,738	4,490	15.0 a-d	9.6 e	14.9	9.2
10	6,153 a-b	5,769 a-c	4,933	4,123	15.9 a-b	10.7 b-e	15.4	9.4
11	6,700 a	6,838 a-b	5,015	4,898	16.6 a	13.7 a	15.7	10.5
LSD 5%	412		NS		2.4		NS	
LSD 1%	553				—			

TN 1=Taichung native 1. Ch 242=Chianung 242.

* Letters with a dash between are inclusive for the range, grain yields and panicle numbrs with letters in common are not significantly different from each other at the 1% and 5% levels respectively for each variety.

It was also observed that the first crop suffered much more loss of yield from the application of herbicides than the second crop of rice. Since rice toxicity caused by herbicides was heavier in the first crop, difference in the degree of yield reduction associated with crop seasons could be ascribed to the effect of chemical injury. The analysis of yield variance also revealed that difference in grain yield among herbicide treatments was highly significant in the first crop but it failed to reach a significant level in the second one. The influence of crop season on herbicide treatments was further confirmed from combined analysis of yield variance for the first and second crops(Table 8). Crop seasons x treatments interaction was significant at the 5% level indicating that herbicide treatments yielded

differently with crop seasons. It was indicated that low toxicity herbicide such as Saturn yielded similarly in both crop seasons whereas 2,4-D esters or herbicides combined with 2,4-D esters which caused severe phytotoxicity to rice in the first crop, differed greatly in their rice production at different crops. Inasmuch as these granular phenoxy herbicides tend to become highly toxic to rice when temperature is very low, the application of these herbicides in the cold first crop season appears too risky to be recommended for rice farmers in Taiwan, although reasonably high yield was obtained with the application of granular 2,4-D IPE in the first crop of 1969 (Chang 1969).

The application of herbicides generally reduced the number of panicles per hill (Table 7). Difference among herbicide treatments reached the 5 % level of significance in the first crop but it was not significant in the second one, a situation very similar to that of grain yield. it was observed that treatments which produced lower yields were usually associated with less panicles per hill, indicating that the decrease in grain yield was caused largely by the reduction in the number of panicles per hill. As indica variety has stronger tillering ability than japonica variety, Taichung nitive I was capable of faster recovery from chemical injury and suffered less damage to grain yield than Chianung 242.

Table 8. Combined analysis of yield variance for the first and second crops, 1970.

Source of variation	D. F.	Mean square	F value	L. S. D.	
				5%	1%
Crop seasons	1	8,360,300	98.09**	4.00	7.08
Treatments	10	318,732	3.74**	2.10	2.82
Crop seasons x Treatments	10	186,326	2.19*	2.10	2.82
Error a	60	85,235			
Varieties	1	1,086,284	32.80**	3.98	7.01
Crop season x Varieties	1	308	0.01	3.98	7.01
Treatments x Varieties	10	53,900	1.63	2.07	2.78
Crop seasons x Treatments x Varieties	10	30,996	0.94	2.07	2.78
Error b	66	33,115			

* Significant at 5% level. **Significant at 1% level.

SUMMARY

The effects of varietal type and crop season on the performance of some granular herbicides in transplanted rice evaluated at the Chiayi Agricultural Experiment Station, Chiayi, Taiwan, in the first and second crops of 1970 are reportd.

The major weeds of the experimental plots were *Monochoria vaginalis* and *Cyperus difformis* but *Echinochlna crusglli* occupied only a small fraction of the total weed population. The number of weeds in the plots of Chianung 242 was more than that of Taichung native 1 while the growth of weeds in the second crop was better than that of the first crop.

Granular herbicides tested in this experiment generally provided satisfactory control of weeds.Weed control effect of herbicide treatments varied slightly with varietal type in the early stage of rice growth but the control of weeds in the plots of Taichung native 1 appeared better than that of Chianung 242 when it was rated at panicle initiation stage. Most herbicides gave similar control of weed in both crop seasons.

Granular 2,4-D IPE, 2,4-D EE, and TCE-styrene/2,4-D IPE were highly toxic to rice which were followed by MCPCA, EPTC/2.4-D IPE, and CP 53619/2,4-D BE while CP 53619 and Saturn showed very slight or no phytotoxicity to rice. Rice seedling of Taichung native 1 appeared to be more sensitive to chemical injury than Chianung 242 but former variety recovered more quickly and the toxicity ratings were smaller than those of the latter variety when they were recorded at panicle initiation stage. Phytotoxicity of herbicides was more pronounced in the first crop than in the second one

Among herbicides tested, only Saturn applied at 4 days after transplanting outyielded hand weeding, although several other gave rice yield much higher than that of unweeded treatment. Chianung 242 suffered greater reduction of yield than Taichung native 1 while herbicide treatments caused more reduction of yield in the first crop than in the second one. The decrease in grain yield was associated with the reduction in the number of panicles per hill.

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水稻品種與期作對若干水田粒狀除草劑藥效之影響

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摘 要

本文係報告嘉義農業試驗分所與國際稻米研究所合作，於民國59年第1期作及第2期作舉辦水稻品種與期作對若干水田粒狀除草劑藥效之影響試驗所得結果。鴨舌草與球花蒿草爲試驗田之主要雜草，惟水稗之密度極低。日本型品種嘉農242號試區之雜草數目較印度型品種臺中在來1號者爲多，而第2期作之雜草亦多於第1期作。供試之粒狀除草劑均具良好之治草效果，除草劑治草效果之品種間差異在生育初期並不明顯，惟在幼穗分化期則可看出明顯差異。即同一除草劑在嘉農242號試區之治草效果稍劣於臺中在來1號。除草劑之治草效果受期作之影響甚微。

2,4-D IPE, 2,4-D EE 與 TCE-Styrene/24-D IPE 等粒劑對水稻最具藥害， MCPCA, EPTC /2,4-D IPE 與 CP 53619/2,4-D BE 等粒劑次之，而 CP 53619 與 Saturn 對水稻則未具明顯藥害。臺中在來1號在生育初期似較嘉農 242號易受藥害，惟前者復原情形顯較後者爲優，故在幼穗分化期嘉農242號反較臺中在來1號較具藥害。除草劑對水稻之藥害第一期作顯較第二期作嚴重。

供試除草劑中僅以 Saturn 在插秧後4天施用之處理，產量超過人工除草處理。施用除草劑而減產之程度，嘉農242號較臺中在來1號爲大，而第1期作則大於第2期作。